PB84-240753

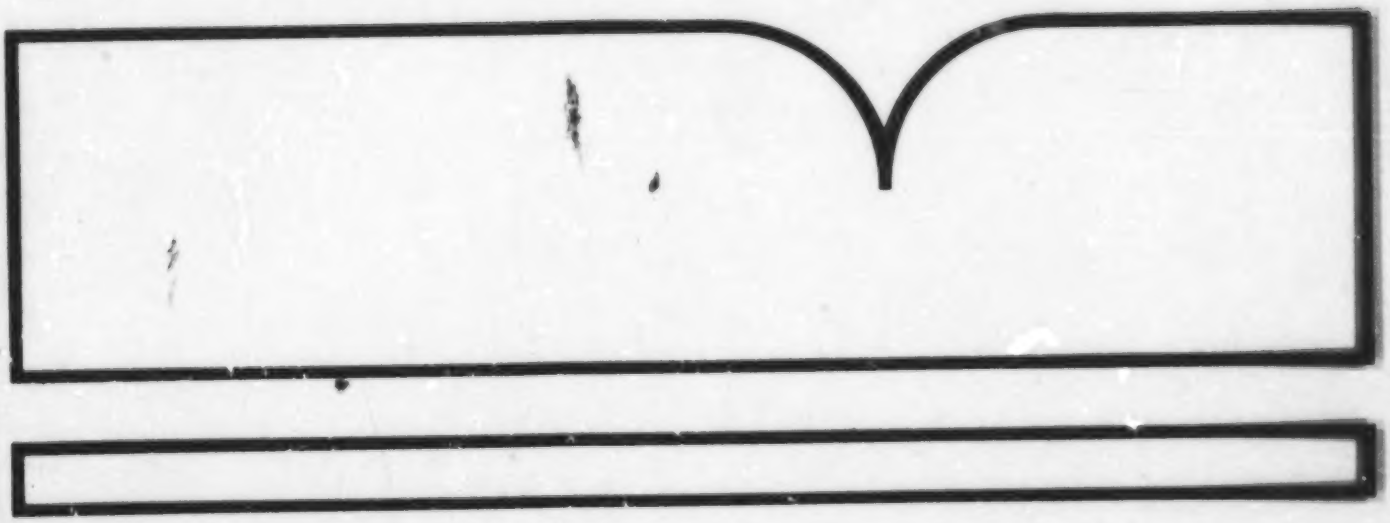
Water Chemicals Codex: Supplementary Recommendations for Direct Additives

National Research Council, Washington, DC

Prepared for

Environmental Protection Agency, Washington, DC

Aug 84



U.S. Department of Commerce
National Technical Information Service
NTIS

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. CLS/FNB 180	2.	3. Recipient's Accession No. PB84 240753
4. Title and Subtitle: WATER CHEMICALS CODEX: SUPPLEMENTARY RECOMMENDATIONS FOR DIRECT ADDITIVES			5. Report Date: August, 1984 6.
7. Author(s): Committee on Water Treatment Chemicals			8. Performing Organization Rept. No. CLS/FNB 180
9. Performing Organization Name and Address: National Research Council Commission on Life Sciences 2101 Constitution Avenue, N.W. Washington, D.C. 20418			10. Project/Task/Work Unit No. 11. Contract(C) or Grant(G) No. (C) 68-01-6795 (G)
12. Sponsoring Organization Name and Address: Environmental Protection Agency Procurement Branch, Water Section 401 M Street, S.W. Washington, D.C. 20460			13. Type of Report & Period Covered: final 14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

Report contains monographs for chemicals used to prepare potable water.

17. Document Analysis a. Descriptors

water chemicals
water additives
drinking water chemicals

b. Identifiers/Open-Ended Terms

potable water

c. COSATI Field/Group

18. Availability Statement: This report has been approved for public sale; it distribution is unlimited.	19. Security Class (This Report) unclassified	21. No. of Pages 25
	20. Security Class (This Page)	22. Price

PB84-240753

WATER CHEMICALS CODEX :

SUPPLEMENTARY RECOMMENDATIONS FOR DIRECT ADDITIVES

Committee on Water Treatment Chemicals
Food and Nutrition Board
Commission on Life Sciences
National Research Council

1984

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SPRINGFIELD, VA. 22161

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This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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The work on which this publication is based was performed pursuant to Contract No. 68-01-6795 with the Environmental Protection Agency.

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INTRODUCTION

The Committee on Water Treatment Chemicals (CWTC) of the National Research Council's Food and Nutrition Board published the Water Chemicals Codex in 1982.[1] The purpose of the Codex was to furnish the water treatment industry with recommended purity standards for chemicals used to prepare potable water. Although the recommendations are based on current drinking water standards, they do not have regulatory status. It was hoped, however, that they would be adopted voluntarily by the water treatment industry.

The initial Codex consisted of individual monographs on 32 bulk chemicals used as direct additives. Each monograph identified the most likely contaminants found in the additive, a recommended maximum limit for each contaminant, and citations of the best analytical procedures for measuring contaminant levels. At the time of publication of the Codex, it was recognized that it would have to be updated periodically to reflect changes in drinking water standards and to include additional bulk direct additives when appropriate.

The monographs included in this report were prepared by the CWTC in response to a request by the Environmental Protection Agency (EPA) for additional monographs. EPA also asked the CWTC to solicit from Codex purchasers suggested additions and modifications to improve the usefulness of the Codex. The Committee designed a questionnaire to obtain such suggestions (see Appendix A). The questionnaire was sent to 636 Codex purchasers and 254 responded.

The suggestions for additional information were limited to new monographs and the inclusion of safety information. Seven new monographs were requested, all but one of which were already under development by the Committee. The seventh was added to the list. Product safety and handling considerations are addressed in the additive standards published by the American Water Works Association, and the Committee thought it inappropriate to repeat this information in the Codex.

There were no suggestions for modification of existing material.

During the preparation of the Codex, the Committee was aware of a class of direct additives known as formulated products. These are not single substances, but rather mixtures of chemicals. The Committee chose not to include formulated products in the Codex but to address them in the first supplement. This report includes the Committee's position on formulated products.

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1. National Research Council, Committee on Water Treatment Chemicals, Water Chemicals Codex. Washington, D.C: National Academy Press, 1983.

FORMULATED PRODUCTS

The Committee recognizes that the exact formulation of a special-purpose or formulated direct drinking water additive may be proprietary. Yet there may be a need to be concerned about the purity of such products. In addition to the issue of proprietary information, some formulated products may contain components that are not listed in the Codex. The Committee recommends that formulated products be treated as follows.

In Type I formulated products, every ingredient of the formulated products is the subject of a monograph in the the Codex. A Type I product should not exceed the Recommended Maximum Impurity Content values (RMIC's) for the contaminants identified in the monographs when used at the maximum dosages recommended. RMIC's are to be taken from the Table in Appendix B or calculated from the equation on page 5 of the Codex. (Note: It is the sum of all contaminant concentrations that must not exceed an RMIC.)

There are also Type II formulated products which contain components that are not described by monographs in the Codex. The absence of a monograph makes it impossible to cite an RMIC as a measure of safety because RMIC's are developed after Committee evaluation of the toxicological significance of the most likely contaminants in a chemical.

Concurrently with the development of the monographs presented here, the CWTC is preparing a report for EPA on how the agency might implement a plan to evaluate indirect drinking water additives, such as paints, coatings, polymeric coagulant aids, and other complex mixtures. The Committee recommends that the category of Type II formulated products be included in the types of materials to be evaluated by the mechanism that EPA adopts for evaluating indirect additives.

Name: Aluminum Chloride

CAS No.: 7446-70-0

Chemical Formula: $AlCl_3$ Formula Weight: 133.3

Description:

Commonly available in a solution 28% $AlCl_3$ by weight. Solution is colorless to slight amber.

Use:

Used as a coagulant for water treatment.

Purity Requirements:

The Recommended Maximum Impurity Content (RMIC) values are based on a maximum dosage of 70 mg aluminum chloride /liter* of water and are to be compared to impurity concentration obtained by using sample procedures described in the monograph. If the actual dosage is other than 70 mg/liter, the user is advised to consult the table in Appendix B for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Aluminum Chloride*
Arsenic	100
Cadmiun	20
Chromium	100
Lead	100
Mercury	4
Selenium	20
Silver	100

*Calculated on the dry weight basis of $AlCl_3$.

Aluminum chloride may be produced from alumina or as a by-product during the manufacture of a variety of organic compounds. By-product aluminum chloride may contain organic contamination; therefore, care should be exercised in the use of aluminum chloride recovered from organic syntheses.

Analytical Sample Preparation:

In preparing samples, use acid-washed glassware and make all dilutions with deionized distilled water. Weigh 0.4g of aluminum chloride (dry weight basis), dissolve, and make up to 1 liter in a volumetric flask. Transfer the solution to a 1.5-liter beaker; add 1 N NaOH dropwise with constant stirring to adjust to pH 6. Mix well, let stand for 1 hour, and filter through a GF/C filter (or equivalent) with vacuum. Quantitatively transfer filtrate into a beaker, adjust to pH 2 or less with concentrated HNO_3,

and evaporate on a hot plate, without boiling, to reduce the volume to less than 1 liter. Cool, quantitatively transfer to a 1-liter volumetric flask, and make up to volume. Similarly treat a reagent blank.

Sample Analyses:

The analyses are to be performed on the aluminum chloride solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Cadmium	Section 304
Chromium	Section 304
Lead	Section 304
Mercury	Section 303F
Selenium	Section 304
Silver	Section 304

Name: Copper Sulfate

CAS No.: 7758-98-7

Chemical Formula: $CuSO_4.5H_2O$ **Formula Weight:** 249.5

Description:

Blue or ultramarine triclinic crystals or blue crystalline granules or powder which slowly effloresce in air. The most common hydrate, $CuSO_4.5H_2O$, has a solubility in water of 26.3g/100 mL at 20°C and is available at a commercial strength of 99%.

Use:

Used for algae control in water storage facilities and impoundments.

Purity Requirements:

The Recommended Maximum Impurity Content (RMIC) are based on a maximum dosage of 4 mg of copper sulfate/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 4 mg/liter, the user is advised to consult the table in Appendix B for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Copper Sulfate
Cadmium	200
Selenium	200

Analyses of available grades of copper sulfate also show the presence of arsenic, lead, and silver but at levels below those that would necessitate RMIC values based on a maximum dosage of 4 mg copper sulfate/liter of water.

Bulk Sample Collection:

Sample in accordance with Standard for Copper Sulfate, AWWA B602-80, American Water Works Association, Denver, Colorado (1980).

Analytical Sample Preparation:

Weigh out 2.5 grams of copper sulfate in a 150 mL acid-washed beaker and dissolve the sample in 100 mL of deionized distilled water. Under a hood, acidify the solution with concentrated HNO_3 to a pH of less than 2. Gently heat the solution to reduce the volume below 100 mL, making certain that it does not boil. Quantitatively transfer to a 100mL acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Analyses:

The analyses are to be performed on the copper sulfate sample in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Cadmium	Section 304
Lead	Section 304
Selenium	Section 304
Silver	Section 304

All products used for disinfection that contain this compound must be registered as prescribed by the Federal Insecticide, Fungicide and Rodenticide Act.

Name: Hydrochloric Acid

CAS No.: 7647-01-0

Chemical Formula: HCl Formula Weight: 36.5

Description:

A colorless to pale straw colored solution available in various concentrations of hydrogen chloride by weight. Commonly used by the water treatment industry at a concentration of 31.5% HCl by weight.

Use:

Used to generate chlorine dioxide from sodium chlorite, adjustment of pH, regeneration of ion exchange resins.

Purity Requirements:

A maximum dosage of 40 mg of hydrochloric acid/liter of water was considered, and at that dosage, hydrochloric acid, produced by the burner process, is not known to contribute any contaminants that adversely affect the potability of drinking water. Hydrochloric acid is also generated as a by-product of many industrial processes, and may contain a variety of contaminants. Therefore, caution should be exercised in the use of acids from these sources.

Name: Phosphoric Acid

CAS No.: 7664-38-2

Chemical Formula: H_3PO_4 Formula Weight: 97.9

Description:

Clear, colorless, slightly viscous liquid, 75-85% H_3PO_4 by weight.

Use:

Used as a component in formulated corrosion inhibitor products.

Purity Requirements:

A maximum dosage of 10 mg of electric furnace prepared phosphoric acid/liter of water was considered, and at that dosage phosphoric acid is not known to contribute any contaminants that adversely affect the potability of drinking water. Phosphoric acid also is made by the wet process extraction of phosphate rock. Such acid may contain organic, inorganic, and radioactive contaminants. Therefore, caution should be exercised in the use of phosphoric acid prepared by the wet extraction process.

Name: Polyaluminum Chloride

CAS No.: 1327-41-9

Chemical Formula: not defined

Description:

Clear or pale yellow liquid containing 10 to 18% aluminum as Al_2O_3. Solutions are available with a range of neutralization by base, typically ranging from 50 to 80 per cent.

Use:

Used as a coagulant and coagulant aid.

Purity Requirements:

The Recommended Maximum Impurity Content (RMIC) values are based on a maximum dosage of 25 mg polyaluminum chloride/liter of water* and are to be compared to impurity concentration obtained by using sample procedures described in the monograph. If the actual dosage is other than 25 mg/liter, the user is advised to consult the table in Appendix B for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Polyaluminum Chloride*
Arsenic	200
Cadmium	40
Chromium	200
Lead	200
Mercury	8
Selenium	40
Silver	200

*Calculated on the basis of polyaluminum chloride expressed as Al_2O_3.

Analytical Sample Preparation:

In preparing samples, use acid-washed glassware and make all dilutions with deionized distilled water. Weigh 0.4g of polyaluminum chloride (dry weight basis), dissolve, and make up to 1 liter in a volumetric flask. Transfer the solution to a 1.5-liter beaker, add 1 N NaOH dropwise with constant stirring to adjust to pH 6. Mix well, let stand for 1 hour, and filter through a GF/C filter (or equivalent) with vacuum. Quantitatively transfer filtrate into a beaker, adjust to pH 2 or less with concentrated HNO_3, and evaporate on a

hot plate, without boiling, to reduce the volume to less than 1 liter. Cool, quantitatively transfer to a 1-liter volumetric flask, and make up to volume. Similarly, treat a reagent blank.

Sample Analyses:

The analysis is to be performed on the polyaluminum chloride sample in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Cadmium	Section 304
Chromium	Section 304
Lead	Section 304
Mercury	Section 303F
Selenium	Section 304
Silver	Section 304

Name: Sodium Hypochlorite

CAS No.: 7681-52-9

Chemical Formula: NaOCl **Formula Weight:** 74.5

Description:

Commonly available as a clear, light-yellow solution with a pungent odor. It is corrosive and deteriorates rapidly.

Use:

Used in disinfection, taste and odor control, color, iron, and manganese removal.

Purity Requirements:

The Recommended Maximum Impurity Content (RMIC) values are based on a maximum dosage of 20 mg of sodium hypochlorite/liter of water as chlorine, and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 20 mg/liter, the user is advised to consult the table in Appendix B for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Sodium Hypochlorite as Chlorine
Carbon Tetrachloride	20
Mercury	10
Trihalomethanes	500

Bulk Sample Collection:

Sample in accordance with Standard for Sodium Hypochlorite, AWWA B300-80, American Water Works Association, Denver, Colorado (1980).

Analytical Sample Preparation: Inorganic

Extraction Solution - Pour 100 mL of sodium hypochlorite into a 150 mL acid-washed beaker. Under a hood, acidify with concentrated HCl to a pH of less than 2. To prevent explosive decomposition during analysis, add KI until an excess of I_2 is indicated by a dark straw color. Gently heat the solution to reduce the volume below 100 mL, making certain that it does not boil. Quantitatively transfer to a 100 mL acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses - Inorganic

The analyses are to be performed on the sodium hypochlorite solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981)

Mercury	Section 303F

Analytical Sample Preparation: Organic

Extraction - Extract 5 ml of sodium hypochlorite with an equal volume of pentane in a 15 ml glass vial with a TFE lined screwcap. Shake vigorously for 1 minute. Let phases separate and inject the organic phase into a gas chromatograph.

Sample Analyses - Organic

The analyses are to be performed on the sodium hypochlorite extract in accordance with:

> Supplement to the Fifteenth Edition of Standard Methods for the Examination of Water and Wastewater, Selected Analytical Methods Approved and Cited by the United States Environmental Protection Agency, American Public Health Association, Washington, D.C. (1981), S92. (U.S. Environmental Protection Agency, Method 501.2)

All products used for disinfection that contain this compound must be registered as prescribed by the Federal Insecticide, Fungicide and Rodenticide Act.

Name: Tannin Derivatives

CAS No.: not available

Chemical Formula: not defined

The Mannich reaction product of vegetable tannin (quebracho, mymosa, wattle, and the like) with an amine and formaldehyde. Molecular weight typically 10,000 to 30,000.

Description:

A dark brown solution with a pleasant odor.

Use:

Clarification of potable water.

Purity Requirements:

Analyses of available grades of tannin derivatives show the presence of formaldehyde but at levels below those that would necessitate an RMIC value based on a maximum dosage of 15 mg tannin derivative/liter of water. If analysis is desired, the following protocol is recommended.

Analytical Sample Preparation

To 5 mL of tannin derivatives in a 10-mL centrifuge tube carefully add 50% H_2SO_4 to a pH of 3.5-4, or until a precipitate forms. Let precipitate settle or centrifuge.

Sample Analysis:

The analysis is to be performed on the tannin supernatant in accordance with:

Official Methods of Analyses, 13th Edition, Association of Official Analytical Chemists, Washington, D.C. (1980)

formaldehyde Section 6.350

Name: Zinc Chloride

CAS No.: 7646-85-7

Chemical Formula: $ZnCl_2$ **Formula Weight:** 135.4

Description:

Clear, colorless crystal or granular powder.

Use:

Component in formulated corrosion inhibitor products.

Purity Requirements:

Analyses of available grades of zinc chloride show the presence of lead and cadmium but at levels far below those that would necessitate a Recommended Maximum Impurity Content value (RMIC) based upon a maximum dosage of 10 mg/liter. If analysis is desired, the following protocol is recommended.

Bulk Sample Collection:

Sample in accordance with Standard for Sodium Chloride, AWWA B200-78, American Water Works Association, Denver, Colorado (1978).

Analytical Sample Preparation:

Weigh out 2.5 g of zinc chloride. In a 150 mL acid-washed beaker, dissolve the sample in 100 mL of deionized distilled water. Under a hood, acidify the solution with concentrated HCl to a pH of less than 2. Gently heat the solution to reduce the volume below 100 mL, making certain that it does not boil. Quantitively transfer to a 100 mL acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses:

The analyses are to be performed on the zinc chloride sample in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Cadmium	Section 304
Lead	Section 304

Name: Zinc Sulfate

CAS No.: 7733-02-0

Chemical Formula: $ZnSO_4H_2O$ Formula Weight: 179.6

Description:

White, crystalline solid.

Use:

Component in formulated corrosion inhibitor products.

Purity Requirements:

Analyses of available grades of zinc sulfate show the presence of lead and cadmium but at levels far below those that would necessitate a Recommended Maximum Impurity Content (RMIC) value based upon a maximum dosage of 5 mg/liter. If analysis is desired, the following protocol is recommended.

Bulk Sample Collection:

Sample in accordance with Standard for Sodium Chloride, AWWA B200-78, American Water Works Association, Denver, Colorado (1978).

Analytical Sample Preparation:

Weigh out 2.5 g of zinc sulfate. In a 150 mL acid-washed beaker, dissolve the sample with 100 mL of deionized distilled water. Under a hood, acidify the solution with concentrated HCl to a pH of less than 2. Gently heat the solution to reduce the volume below 100 mL, making certain that it does not boil. Quantitively transfer to a 100 mL acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses:

The analyses are to be performed on the zinc sulfate sample in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Cadmium	Section 304
Lead	Section 304

APPENDICES

APPENDIX A

Users Survey

Name of organization responding _____

Supplier _____ Utility _____ Mgd _____

WATER TREATMENT CHEMICALS CODEX

The National Academy of Science records show that you purchased a Water Chemical Codex which contains information on the description, uses, purity recommendations and analytical procedures for water treatment chemicals.

The NAS is interested in learning how you have used the Codex and also to get your advice for future improvments to the Codex.

1. Do you use the Codex?
   - -Never
   - -Occasionally
   - -Frequently

2. How do you use the Codex?
   - -Purchasing specifications
   - -General information
   - -Analytical methods
   - -other _____

3. Additional chemicals are currently being added to the Codex. What additional chemical would you reccommend for inclusiion?
   - a) _____
   - b) _____
   - c) _____
   - d) _____

4. Do you have suggestions for changes in the monographs?
   - a) RMIC values _____
   - b) Consider RMIC values for additional impurities such as
     _____
     _____
     _____
   - c) dosage levels _____
   - d) Analytical Procedures _____
   - e) other _____

Calculated Values of RMIC (mg/kg) at Various Additive Use Levels

Substance	MCL mg/L	CWTC* mg/L	Use Levels 1 mg/L	5 mg/L	10 mg/L	50 mg/L	100 mg/L	200 mg/L	500 mg/L
			RMIC	RMIC	RMIC	RMIC	RMIC	RMIC	RMIC
Arsenic	0.05		5,000	1,000	500	100	50	25	10
Barium	1		100,000	20,000	10,000	2,000	1,000	500	200
Cadmium	0.01		1,000	200	100	20	10	5	2
Carbon Tetrachloride*	-	0.003	300	60	30	-	-	-	-
Chromium	0.05		5,000	1,000	500	100	50	25	10
Ether Extractable Matter	**								
Fluoride	values are temperature dependent								
Lead*	0.05	0.02	2,000	400	200	40	20	10	4
Mercury	0.002		200	40	20	4	2	1	0.4
Nitrate	10		1,000,000	200,000	100,000	20,000	10,000	5,000	2,0
Pyridine	**								
Selenium	0.01		1,000	200	100	20	10	5	2
Silver	0.05		5,000	1,000	500	100	50	25	10
Trihalomethanes	0.1		10,000	2,000	1,000	200	100	50	20

*Calculated by NAS Committee on Water Treatment Chemicals
**Applicable only to Ammonium Sulfate, purity defined by AWWA